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1921/22

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Oregon Agricultural College Bulletin

School of Mines
1921-22

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CORVALLIS, OREGON

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School of Mines

1921-22

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CORVALLIS, OREGON

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1921

OREGON AGRICULTURAL COLLEGE

The work of the Oregon Agricultural College is organized into three main divisions: Resident Instruction, Experiment Station, and Extension Service.

I.—THE RESIDENT INSTRUCTION DIVISION includes

The School of Agriculture (*B.S., M.S. Degrees*)

With departments of Animal Husbandry, Dairy Husbandry, Farm Crops, Farm Management, Farm Mechanics, Horticulture (including Pomology, Vegetable Gardening, Landscape Gardening, Floriculture, and Horticultural Products), Poultry Husbandry, Soils, and Veterinary Medicine.

The School of Commerce (*B.S. Degree*)

With departments of Business Administration, Economics and Sociology, Office Training and Stenography, and Political Science.

The School of Engineering and Mechanic Arts (*B.S., C.E., E.E., M.E. Degrees*)

With departments of Civil Engineering, Electrical Engineering, Highway Engineering, Industrial Arts, Mechanics and Materials, Mechanical Engineering, and Chemical Engineering.

The School of Forestry (*B.S., M.S. Degrees*)

With departments of General Forestry and Logging Engineering.

The School of Home Economics (*B.S., M.S. Degrees*)

With departments of Household Administration, Household Art, Household Science, and Institutional Management.

The School of Mines (*B.S. Degree*)

With departments of Geology, Metallurgy, and Mining Engineering.

The School of Pharmacy (*B.S., Ph.C., Ph.G. Degrees*)

The School of Vocational Education (*B.S. Degree*)

With departments of Agricultural Education, Commercial Education, Education, Home Economics Education, Industrial Education, and Psychology.

The Department of Military Science and Tactics (*B.S. Degree*)

Including Reserve Officers Training Corps in Infantry, Field Artillery, Engineers, Motor Transport, and Cavalry.

The Service Departments

Including departments of Art and Rural Architecture, Bacteriology, Botany and Plant Pathology, Chemistry, English Language and Literature, Entomology, History, Mathematics, Modern Languages, Physics, Public Speaking and Dramatics, Zoology and Physiology, Industrial Journalism, Library Practice, Physical Education for Men, and Physical Education for Women.

The School of Music (Music Diploma)

With departments of Harmony, Theory, Voice, Piano, Violin, Pipe-organ, and Orchestra.

The Short Sessions

Including the Summer Session and Winter Short Courses.

II.—THE EXPERIMENT STATION DIVISION includes

The Home Station, at Corvallis.

The Eastern Oregon Branch Station, at Union.

The Sherman County Dry-Farm Branch Station, at Moro.

The Umatilla Branch Station, at Hermiston.

The Southern Oregon Branch Station, at Talent.

The Harney Valley Branch Station, at Burns.

The John Jacob Astor Branch Station, at Astoria.

The Hood River Branch Station, at Hood River.

III.—THE EXTENSION SERVICE DIVISION includes

County Agricultural Work.

Home Demonstration Work.

Boys' and Girls' Club Work.

Extension Specialist Work

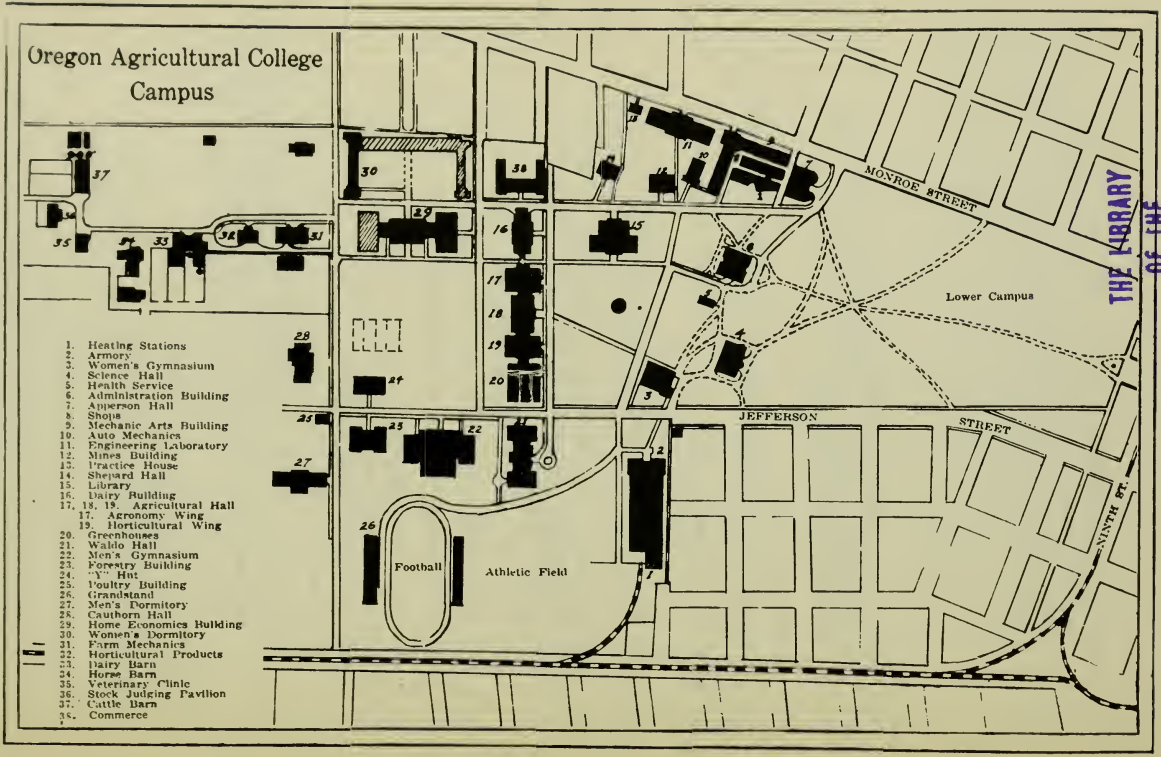
In Animal Husbandry; Dairying; Drainage and Irrigation; Farm Crops; Farm Management; Field Entomology, Plant Pathology, and Bacteriology; Field Horticulture; Poultry Husbandry; Rodent Control; Rural Organization and Markets.

Extension Schools and Meetings.

Extension Publications.

Extension Lectures.

Advisory Correspondence.



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COLLEGE CALENDAR

1921

SEPTEMBER 19, 20, *Monday, Tuesday*.....Registration

SEPTEMBER 21, *Wednesday*.....
.....Recitations begin; required English examination

OCTOBER 7, *Friday*.....Meeting of Board of Regents

NOVEMBER 24, 25, 26, *Thursday, Friday, Saturday*.....
.....Thanksgiving recess

DECEMBER 17, *Saturday*.....First term ends; Christmas recess begins

1922

JANUARY 2, 3, *Monday, Tuesday*.....
.....Second term registration; Winter Short Courses begin

JANUARY 4, *Wednesday*.....
.....Recitations begin; meeting of Board of Regents

JANUARY 28, *Saturday*.....Winter Short Courses end

FEBRUARY 22, *Wednesday*.....Washington's birthday; holiday

MARCH 18, *Saturday*.....Second term ends; spring vacation begins

MARCH 27, 28, *Monday, Tuesday*.....Third term registration

MARCH 29, *Wednesday*.....Recitations begin

APRIL 5, *Wednesday*.....Meeting of Board of Regents

MAY —, ...Military Inspection Day

MAY 30, *Tuesday*.....Decoration Day; holiday

JUNE 3, *Saturday*.....Last day of recitations for third term

JUNE 5-10, *Monday to Saturday*.....Final examinations

JUNE 10, *Saturday*.....Senior Class Day; Alumni Reunion

JUNE 11, *Sunday*.....Baccalaureate Sermon

JUNE 12, *Monday*.....Fifty-third Annual Commencement

JUNE 12-17, *Monday noon to Saturday*.....Farmers' Week

JUNE 19, *Monday*.....Summer Session begins

JULY 29, *Saturday*.....Summer Session ends

BOARD OF REGENTS

OFFICERS

Hon. J. K. Weatherford, President.....Albany
Hon. N. R. Moore, Secretary.....Corvallis
Hon. B. F. Irvine, Treasurer.....Portland

EX-OFFICIO MEMBERS

Hon. Ben W. Olcott, Governor.....Salem
Hon. Sam A. Kozer, Secretary of State.....Salem
Hon. J. A. Churchill, Superintendent of Public Instruction.....Salem
Hon. Charles E. Spence, Master of State Grange.....Oregon City

APPOINTED BY THE GOVERNOR

	Term expires
Hon. B. F. Irvine	Portland, 1924
Hon. N. R. Moore	Corvallis, 1924
Hon. Jefferson Myers	Portland, 1924
Hon. J. K. Weatherford	Albany, 1927
Hon. C. L. Hawley	Portland, 1927
Hon. M. S. Woodcock	Corvallis, 1927
Hon. Walter M. Pierce	La Grande, 1929
Hon. H. von der Hellen	Wellen, 1929
Hon. Geo. M. Cornwall	Portland, 1929

STANDING COMMITTEES

EXECUTIVE COMMITTEE

J. K. Weatherford, Chairman, C. E. Spence, W. M. Pierce, J. Myers, C. L. Hawley

FINANCE COMMITTEE

M. S. Woodcock, J. Myers, H. von der Hellen

COLLEGE COMMITTEE

J. A. Churchill, Chairman; S. A. Kozer, N. R. Moore

STATION COMMITTEE

W. M. Pierce, Chairman; H. von der Hellen, Geo. M. Cornwall, M. S. Woodcock, B. W. Olcott

FORESTRY COMMITTEE

Geo. M. Cornwall, Chairman; Ben W. Olcott, M. S. Woodcock

EXTENSION COMMITTEE

J. Myers, Chairman; C. L. Hawley, C. E. Spence, H. von der Hellen, N. R. Moore

BUILDING COMMITTEE

J. K. Weatherford, M. S. Woodcock, N. R. Moore

ADMINISTRATIVE COUNCIL

WILLIAM JASPER KERR, D.Sc., LL.D., President of the College.
President.

ARTHUR BURTON CORDLEY, D.Sc.,
Dean of the School of Agriculture.

GRANT ADELBERT COVELL, M.E.,
Dean of the School of Engineering and Mechanic Arts; Professor of Mechanical Engineering.

JOHN ANDREW BEXELL, A.M.,
Dean of the School of Commerce; Professor of Business Administration.

EDWIN DEVORE RESSLER, A.M.,
Dean of the School of Vocational Education; Professor of Education.

GEORGE WILCOX PEAVY, M.S.F.,
Dean of the School of Forestry.

MARY ELIZA FAWCETT, A.M.,
Dean of Women.

ADOLPH ZIEFLE, Ph.C., M.S.,
Dean of the School of Pharmacy.

AVA BERTHA MILAM, Ph.B., A.M.,
Dean of the School of Home Economics.

CHARLES EDWARD NEWTON, E.M.,
Dean of the School of Mines.

M. ELLWOOD SMITH, Ph.D.,
Dean of the Service Departments; Director of the Summer Session.

PAUL VESTAL MARIS, B.S.,
Director of the Extension Service.

JAMES TERTIUS JARDINE, B.S.,
Director of the Experiment Station.

School of Mines

William Jasper Kerr, D.Sc., LL.D., President of the College.
Charles Edward Newton, B.S., E.M., Dean of the School of Mines.
Myrtle Burnap, B.S., Secretary to the Dean.

James Hervey Batcheller, S.B., Associate Professor of Mining.
Douglas Clermont Livingston, B.S. (Mining Eng.), Professor of Geology.

*Service Departments**

Mahlon Ellwood Smith, Ph.D., Dean of the Service Departments; Director of Summer Session.
John Fulton, M.S., Professor of Chemistry.
Charles Leslie Johnson, B.S., Professor of Mathematics.
William Ballantyne Anderson, Ph.D., Professor of Physics.
Edward Benjamin Beaty, A.M., Associate Professor of Mathematics.
Louis Sherman Davis, Ph.D., Associate Professor of Chemistry.
Frederick Charles Kent, A.B., Associate Professor of Mathematics.
Nicholas Tartar, B.S., Assistant Professor of Mathematics.
Harry Lynden Beard, B.S., Assistant Professor of Mathematics.
Harold Kelley, B.S., Instructor in Chemistry.
John Albert van Groos, M.S., Instructor in Mathematics.
McKinley Helm, B.S., Instructor in English.
Jacob Jordan, Instructor in Physics.
Osman Horace Cady, M.S., Instructor in Chemistry.
Harry Drill, A.B., Instructor in Physics.

*Other Schools and Departments**

John Andrew Bexell, A.M., Dean of the School of Commerce.
Ulysses Grant Dubach, Ph.D., Professor of Government and Business Law.
Samuel Herman Graf, M.S., Professor of Mechanics and Materials.
Joseph Kepner Partello, Lieutenant Colonel United States Army; Professor of Military Science and Tactics; Commandant of Cadets.
Wallace Hope Martin, M.E., Professor of Heat Engineering.
Stuart Hobbs Sims, B.S. in C.E., Professor of Civil Engineering.
Richard Burr Rutherford, A.B., Professor of Physical Education for Men; Director of Intercollegiate Athletics.

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*Here are listed members of other faculties offering courses open to students in Mines.

Newel Howland Comish, M.S., Professor of Economics.
Floyd Rowland, Ph.D., Professor of Chemical Engineering.
Frank Abbott Magruder, Ph.D., Associate Professor of Government and Business Law.
Samuel Michael Patrick Dolan, C.E., Associate Professor of Civil Engineering.
Dexter Ralph Smith, B.S., Assistant Professor of Civil Engineering.
Ray Boals, B.S., Assistant Professor of Mechanical Engineering.
Ivan Frederick Waterman, B.S., Instructor in Mechanics and Materials.
Burdette Glenn, B.S., Instructor in Civil Engineering.
William Horning, Instructor in Industrial Arts.

The curriculum in Mines is designed to give thorough training in the fundamentals of the science of Geology, and the arts of Mining and Metallurgy, and to prepare for positions of responsibility in the industrial life of the country, particularly in the mining field. The curriculum is of such a comprehensive character that a graduate finds it of aid in varied employments. The opportunities which are open to a graduate of the School of Mines include such positions as assayer, chemist, or metallurgist at mines and smelters; member of staffs of the Government and state geological surveys; member of the staff of the Government Coast and Geodetic Survey; land or deputy mineral surveyor; draftsman and designer in engineering establishments; member of the engineering and geological staffs of mining, oil, and exploration companies and of railroads; and worker in the land-classification work of the Government forest service. Graduates may expect that after having reached the necessary maturity they will be competent to fill responsible positions in any branches of geology, mining, and metallurgy.

Curriculum. A four-year curriculum, leading to the degree of Bachelor of Science in Mining Engineering, is offered by the School of Mines. Students showing ability are offered the opportunity and encouraged to take special work in that branch of the profession that most interests them, such as geology, mining, or metallurgy.

The first two years in the School of Mines are the same for all students. The work is intended to give the student a thorough knowledge of those studies basic to all branches of engineering; namely, Mathematics, Physics, Chemistry, Mechanical Drawing, Plane Surveying, Shop Work, and courses having general cultural value.

Two months or more employment in industrial lines closely allied to the student's major work is a prerequisite to graduation.

Admission. Detailed statements of entrance requirements, routine of registration, etc., are given in the special bulletin on "General Information," which is furnished on application. Requirements for admission to the curriculum in the School of Mines are as follows:

Applicants must be at least 16 years of age and must have completed 15 units of work in a secondary school recognized as standard, these units to include at least 3 units of English, and 1 unit each of Elementary Algebra and Plane Geometry, together with 5 additional units of English, Mathematics, Foreign Languages, Laboratory Sciences, and History (including Civics).

Equipment. The School of Mines occupies a commodious, three-story and basement building especially designed for housing the lecture rooms and laboratories devoted to Mining, Metallurgy, Ore Dressing, Geology, and closely allied subjects. The assaying and metallurgical laboratory occupies a room 30 feet by 60 feet on the first floor of the building, extending across the entire east end. It is amply lighted and is completely equipped with the necessary apparatus for conveniently and scientifically carrying on experimental metallurgical operations. A crushing and grinding laboratory and an ore-testing laboratory, completely equipped, occupy two rooms in the basement. On the second floor is located the mining drafting room, equipped for topographical drafting, mining and metallurgical design. The geology laboratories occupy the third floor of the Mines Building, and comprise the Geologic and Mining Museum, the mineralogic laboratory, and the petrologic laboratory. In the Museum are arranged collections of ores, minerals, and rocks from the important mining camps in Oregon. Besides these collections there are many attractive specimens of minerals, rocks, and fossils from numerous American localities. Geologic products are shown, such as samples of different clay wares and cement goods. In addition there is a large-scale relief map of the State. The geologic laboratories contain over 12,000 specimens of ores, rocks, and minerals; rock slides for microscopic work; and geologic and topographic maps.

Miners' Club. The Miners' Club is a society composed of all students and faculty members of the School of Mines. All members of this organization are also members of a junior branch of the American Institute of Mining and Metallurgical Engineers. At the monthly meetings of the Club, addresses are made by prominent mining engineers, and papers descriptive of the summer work of the students are presented by the student members.

DEGREE CURRICULUM IN MINING ENGINEERING

B.S. Degree

Freshman Year

	Term 1st	2d	3d
General Chemistry (Ch 104, 105, 106), Qualitative Analysis (Ch 131)	5	5	5
Plane Trigonometry (Mth 111), Elementary Analysis (Mth 131, 132)	4	4	4
Mechanical Drawing (ME 111, 112)	2	2	....
English Composition (Eng 101, 102, 103)	3	3	3
Drawing and Descriptive Geometry (CE 113)	....	....	2
Elements of Geology (G 101)	1	....	....
Elements of Mining (MiE 142)	....	1	....
Elements of Metallurgy (Met 163)	....	....	1
Physical Education (PEm 111, 112, 113)	½	½	½
Military Science and Tactics	2	2	2
	17½	17½	17½

Sophomore Year

Quantitative Analysis (Ch 241, 242)	3	3	....
Chemistry of Fuels (Ch 228)	....	....	3
Differential Calculus (Mth 251, 252), Integral Calculus (Mth 253)	4	4	4
Mining Physics (Ph 221, 222, 223)	3	5	3
Plane Surveying (CE 121)	....	....	5
Crystallography, Plowpipe Analysis, and Determinative Mineralogy (G 211, 212)	5	3	....
Physical Education (PEm 211, 212, 213)	½	½	½
Military Science and Tactics	2	2	2
	17½	17½	17½

Junior Year

Mechanics (MM 351, 352)	3	3	...
Lithology or Rock Study (G 311)	3	....	....
Structural Geology (G 312)	....	2	....
General Geology (G 301)	3	....	....
Mining Machinery and General Mining (MiE 343)	....	....	3
Geologic Surveying and Mapping (G 323)	....	....	3
Mine Surveying (MiE 353)	....	....	3
Assaying (Met 362)	....	4	....
Introduction to Economics (ES 391)	3	....	....
National Government (PS 301) or State and Local Government (PS 302)	....	3	....
Business Management (BA 332)	....	....	3
①Electives	3	3	3
	15	15	15

①Suggested Electives: Strength of Materials (MM 353), Hydraulics (IE 344), Steam Machinery (ME 328).

Senior Year	Term 1st	2d	3d
Mining Methods (ME 441), Mining Engineering (MiE 442), Mine Management (MiE 443)	4	4	3
Metallurgy of Gold and Silver (Met 462), Metallurgy of Copper, Lead, and Zinc (Met 463)	....	4	4
Ore Dressing (Met 481, 482, 483)	3	3	3
Metallurgical Laboratory (Met 492, 493)	....	3	3
Metallurgy of Iron (Met 473)	....	....	1
General Metallurgy (Met 461)	4	....	....
Economic Geology (G 431, 432, 433)	3	3	3
②Electives	3	3	3
	17	20	20

②Suggested Electives: Technical Electricity (EE 251), Assaying (Met 651).

PROPOSED ELECTIVES

Public Speaking.
Industrial Journalism.
Money and Banking.
Modern Languages.
History.
Library Practice.
English.
Industrial Arts courses (woodwork, machine work, auto mechanics, blacksmithing, plumbing).
Steam Power Plants.
Masonry and Foundations.
Industrial Inorganic Chemistry.
Industrial Organic Chemistry.
Electro-Chemical Industries.
Forest Mapping.
Contracts and Specifications.
Engineering Location, Earthworks.
Machine Design.
Topographic Surveying.
Advanced Quantitative Analysis.
Metallography and Pyrometry.
Advanced courses offered in the School of Mines.

NUMBERING AND ARRANGEMENT OF DESCRIPTIONS OF COURSES IN THIS CATALOGUE

Courses in degree curricula are designated by numbers of three digits in which the left-hand digit represents usually the year (as first, second, third, etc.) in which the course is normally pursued; the middle digit represents the group of related courses in the department to which the course belongs; and the right-hand digit represents the sequence of courses in cases where courses normally follow each other in succeeding terms.

GEOLOGY

The courses in Geology are designed primarily to give the student of Mining Engineering a sound knowledge of the principles of the many branches of the science, and a thorough training in geologic technique having a direct bearing upon the mining profession. Advanced technical courses in Geology are open to qualified students. Several geologic courses are especially designed for students in Agriculture, Civil Engineering, and Forestry.

COURSES

G 101. **Elements of Geology.** In order to have the simplest conception of the mining profession, one must have an elementary knowledge of Geology. The aim of this course is to give a general outline of the fundamentals of Geology and to show their correct application to mining engineering.

Required in Mines; elective to others; freshman year; first term; 1 credit; 1 lecture. *C. E. Newton*

G 103. **General Geology for Foresters.** Characteristics of the commoner minerals, rocks, and ores; the more important structural features of rocks and mineral deposits; the criteria for recognizing the various types of ore deposits; practice in the interpretation of geologic and topographic maps to enable students to make use of these maps in the field.

Prerequisite: General Chemistry. Elective in Forestry; freshman year; third term; 3 credits; 2 recitations; 1 laboratory period. Fee $1.00. *D. C. Livingston*

G 202. **Engineering Geology.** A course in general and applied Geology for students in Engineering, emphasizing those phases of the subject with which the civil, irrigation, and highway engineer should be familiar. The origin and nature of the materials of the earth; review of geologic processes which modify the earth's surface; occurrence and nature of geologic structural and road materials; influence of structure of rocks on engineering projects; study of ground waters and effect on water supply and foundation sites; interpretation of geologic and topographic maps; occurrence of ores and other minerals of economic value.

Required in Civil Engineering (sophomore year); elective to others in Engineering (junior or senior year); second term; 3 credits; 3 recitations; 1 two-hour laboratory period. Fee $2.00. Text: Ries and Watson, Engineering Geology. *D. C. Livingston*

G 211. **Crystallography, Blowpipe Analysis, and Determinative Mineralogy.** It is quite essential that the student should have a

practical understanding of Crystallography and to that end considerable time is spent upon the determination of natural crystals. Blowpipe analysis is essentially a field method for the chemical determination of minerals. Determinative Mineralogy, as the name indicates, is the utilization of many methods to determine minerals. Emphasis is given to those physical properties which may be used to determine minerals in the field.

Required in Mines; sophomore year; first term; 5 credits; 2 recitations; 4 two-hour laboratory periods. Fee $4.00. Deposit $1.50. Text: Moses and Parsons, Mineralogy, Crystallography, and Blowpipe Analysis. *D. C. Livingston*

G 212. **Mineralogy.** A continuation of Determinative Mineralogy, G 211. In addition a certain amount of time is spent in the study of the occurrence and origin of minerals.

Prerequisite: G 211. Required in Mines; sophomore year; second term; 3 credits; 1 recitation; 3 two-hour laboratory periods. Fee $2.00. Deposit $1.50. Text: Moses and Parsons, Mineralogy, Crystallography, and Blowpipe Analysis. *D. C. Livingston*

G 214. **Crystallography.** Briefer course than G 211.

Required in Chemical Engineering; sophomore year; first term; 3 credits; 1 recitation; 3 two-hour laboratory periods. Fee $2.50. Deposit $1.50. *J. H. Batcheller*

G 215. **Mineralogy.** Topics covered in G 212 adapted to needs of Chemical Engineering students.

Required in Chemical Engineering; sophomore year; second term; 3 credits; 1 recitation; 3 two-hour laboratory periods. Fee $2.00. Deposit $1.50. *J. H. Batcheller*

G 301. **General Geology.** Fundamental principles of Geology; practice in the interpretation of geologic and topographic maps; summary of the historical geology and stratigraphy of North America.

Prerequisite: General Chemistry. Required in Mines; elective to others; junior year; first term; 3 credits; 3 recitations. Fee $1.00. Text: Pirsson and Schuchert, Textbook of Geology.

D. C. Livingston

G 302. **General Geology for Students in Agriculture.** This course is designed to present effectively the subject of Geology to the Agriculture student. The fundamental principles are given, and their application to agriculture is emphasized. In the laboratory the student studies the common minerals and rocks by practice with extensive collections, so that he may be able to identify them readily in the field. Two field trips are taken, that the student may gain first-hand knowledge of geologic processes.

Prerequisite: General Chemistry. Required in Landscape Gardening and Soils; elective to others in Agriculture; junior year; second term; 3 credits; 3 lectures; 1 two-hour laboratory period. Fee $1.00. *J. H. Batcheller, D. C. Livingston*

G 311. **Lithology or Rock Study.** This course is intended to familiarize the student with the characteristics of the commoner rocks so that he may identify them in the field. Rocks, their origin, mode of occurrence, and alteration; emphasis upon the numerous petrologic facts and principles which bear an immediate relation to mining operations.

Prerequisites: G 212 and 301. Required in Mines; junior year; first term; 3 credits; 2 lectures; 2 two-hour laboratory periods. Fee $1.00. *D. C. Livingston*

G 312. **Structural Geology.** Continuation of G 311. This course treats of the greater features observed in the rocks, with emphasis on those important to the mining engineer, as faults, folds, and metamorphism.

Prerequisite: G 311. Required in Mines; junior year; second term; 2 credits; 1 lecture; 2 two-hour laboratory periods. Fee $1.00. *D. C. Livingston*

G 323. **Geologic Surveying and Mapping.** A study of the principles and methods of geologic surveying and mapping and their application to field work. The student is assigned a small area and is required to make a geologic map and report, based upon the results of his field work. A two-week trip is made to a mining locality showing a variety of geologic features.

Prerequisite: G 312. Required in Mines; junior year; third term; 3 credits; 1 recitation; 6 hours in field and laboratory. Fee $2.00. *D. C. Livingston, J. H. Batcheller*

G 413. **Petrography.** A more advanced course in Petrology. The optical properties of the rock-forming minerals and the characteristics of the principal rock types are studied with the aid of thin sections and polarizing miscroscope. Type collections with their corresponding rock sections are available, and the student has the opportunity to supplement field determinations with the exact knowledge gained through the use of the microscope.

Prerequisites: G 311 and 312. Elective; third term; 3 credits; 1 recitation; 3 two-hour laboratory periods. Fee $3.00. *D. C. Livingston*

G 422. **Interpretation of Geologic and Topographic Maps.** Study of the representation of geologic and topographic data; interpretation of geologic maps and cross-sections of topographic maps;

methods of plotting geologic data on engineering maps; a large number of Government and other geologic and topographic maps covering varied regions of the United States studied in detail.

Elective in Mines, Engineering, and Forestry; junior or senior year; second term; 2 credits; 2 laboratory periods. Fee $1.00.

D. C. Livingston, J. H. Batcheller

G 431. **Economic Geology.** A study of the many and various factors pertaining to the application of geology to industry. Geologic occurrence of coal, petroleum, gas, clay, building stone, ore deposits, and the like is carefully studied and particular attention is given to those characteristics affecting economic value.

Required in Mines; senior year; first term; 2 credits; 2 recitations. Text: Lindgren, Mineral Deposits. *D. C. Livingston*

G 432. **Economic Geology.** Continuation of G 431. The principles of ore deposition are taken up in detail.

Prerequisite: G 431. Required in Mines; senior year; second term; 3 credits; 3 recitations. Text: Lindgren, Mineral Deposits.

D. C. Livingston

G 433. **Economic Geology.** Various types of deposits that occur in important mining camps are discussed, and written abstracts are required from literature bearing on the subject. Considerable importance is attached to the laboratory work, which consists of mineralogic and petrologic study of rocks and ores from type deposits. A certain amount of time is devoted to a discussion of field methods, mine examinations, and reports.

Prerequisite: G 432. Required in Mines; senior year; third term; 3 credits; 2 recitations; 1 three-hour laboratory period. Fee $1.00. *D. C. Livingston*

G 632. **Problems in Economic Geology.** Problems in mining and field geology are worked out by the student in the laboratory and drafting room. Geologic, topographic, and mine maps are used, and many structural problems are studied, with special regard to their application to the development of mineral deposits.

Prerequisite: G 431. Elective; senior year; second term; 2 credits; 2 laboratory periods. Fee $1.00. *D. C. Livingston*

G 611. **Geology of Igneous Rocks.** A course dealing with the origin of igneous rock bodies and designed for graduate or advanced students. Such subjects as magnetic differentiation, the mechanism of intrusive and extrusive action, are discussed in detail, and special attention is given to those subjects that have an important technical bearing, such as contact metamorphism, magmatic waters, gaseous emanations, etc.

Prerequisite: G 413. Elective; first term; 2 credits; 2 recitations. *D. C. Livingston*

G 621. **Historical Geology and Stratigraphy.** Lectures on the origin and history of the earth and plants and animals that have inhabited it; outline of invertebrate paleontology; principles on which is based the determination of the age of fossiliferous rocks by means of "faunal groups" and by recognition of characteristic species.

Prerequisite: G 312. Elective; first term; 3 credits; 3 recitations. *D. C. Livingston*

G 622. **Oil Geology.** A course in the geology of petroleum consisting of a study of the origin, geologic occurrence, geologic structure and distribution of deposits of petroleum and natural gas, with special reference to the oil and gas fields of the United States, Mexico, and South America. Methods of exploring for oil, methods of mapping geologic structure, and methods of recording and filing geologic data bearing upon the geology of oil and gas, are studied.

Prerequisite: G 312. Elective; senior year; second term; 2 credits; 2 lectures or recitations; 1 laboratory period.

D. C. Livingston

METALLURGY

The aim of the various courses in Metallurgy is to give the student a broad and general knowledge of the methods of treating ores, metals, and other products of the mineral industry, including the processes of assaying, amalgamation, cyanidation; general milling methods, such as crushing, grinding, and concentration; and the smelting of ores for iron, copper, lead, and zinc, and the minor metals, and their refining.

COURSES

Met 163. **Elements of Metallurgy.** An introductory course in Metallurgy; various phases of the treatment of ores; use of fuels; the production of metals.

Required in Mines; elective to others; freshman year; third term; 1 credit; 1 lecture. *C. E. Newton*

Met 362. **Assaying.** The quantitative determination of the constituents of reagents; crushing, sampling and assaying of ores; fluxes, and general metallurgical products.

Required in Mines; junior year; second term; 4 credits; 1 recitation; 3 four-hour laboratory periods. Deposit $15.00. Text: Fulton, Manual of Fire Assaying. *C. E. Newton*

Met 461. **General Metallurgy.** Application of the laws of Chemistry and Physics to metals and alloys; study of fuels, refractory materials, metals and alloys; furnaces and the principles of smelting.

Required in Mines; senior year; first term; 4 credits; 4 recitations. Text: Hofman, General Metallurgy. *C. E. Newton*

Met 462. **Metallurgy of Gold and Silver.** Study of the smelting, amalgamation, cyanidation, and other processes for the production of gold and silver from their ores.

Required in Mines; senior year; second term; 4 credits; 4 recitations. *C. E. Newton*

Met 463. **Metallurgy of Copper, Lead, and Zinc.** Study of the method of producing and refining; the economic conditions affecting the production of common non-ferrous metals.

Required in Mines; senior year; third term; 4 credits; 4 recitations. *C. E. Newton*

Met 473. **Metallurgy of Iron.** Study of the smelting of iron from its ores; the production of cast iron and wrought iron and the general varieties of steel.

Required in Mines; senior year; third term; 1 credit; 1 recitation. Text: Bradley Stoughton, Metallurgy of Iron and Steel.

C. E. Newton

Met 481, 482, 483. **Ore Dressing.** The principles of breaking, grinding, concentrating; general treatment of ores by various processes.

Required in Mines; senior year; three terms; 3 credits each term; 3 recitations. Texts: Richards, Textbook of Ore Dressing. Rickard and Ralston, Flotation. *C. E. Newton*

Met 492, 493. **Metallurgical Laboratory.** Laboratory testing in connection with Met 462, Metallurgy of Gold and Silver; Met 463, Metallurgy of Copper, Lead, and Zinc; and Met 481, 482, 483, Ore Dressing.

Required in Mines; senior year; second and third terms; 3 credits each term; 3 three-hour laboratory periods. Fee $5.00. Deposit $5.00 each term. *C. E. Newton, J. H. Batcheller*

Met 651. **Assaying.** The quantitative determination of the constituents of ores, metallurgical products, and fuels.

Elective in Mines; senior year; first term; 3 credits; 1 recitation; 2 three-hour laboratory periods. Fee $5.00. Deposit $5.00. Text: White, Methods in Metallurgical Analysis. *C. E. Newton*

Met 661. **Metallurgy of the Minor Metals.** The metallurgy of mercury, tin, aluminum, nickel, arsenic, and antimony; study of the methods of production and the uses in the arts.

Elective; senior year; first term; 2 credits; 2 recitations.

C. E. Newton

Met 662. **Metallurgical Design.** Study of plant flow sheets; designing of apparatus for metallurgical operations; working up of flow sheets for milling, smelting, and leaching operations.

Elective; senior year; second term; 2 credits; 2 laboratory periods. Fee $2.00. *C. E. Newton*

Met 663. **Electrometallurgy.** The principles, processes, and apparatus involved in using electrical energy for the smelting and refining of ores and metals.

Elective; senior year; third term; 2 credits; 2 recitations.

C. E. Newton

MINING ENGINEERING

The courses in Mining Engineering are intended to equip the student with thorough knowledge of the basic principles of the art of mining which are essential in development of mineral properties, design and construction of mine plants, and management of mines.

COURSES

MiE 142. **Elements of Mining.** An introductory course designed to give the main features of mining, the aim being to summarize the phases that the student takes up in detail later in his work, to acquaint him early in his course with the life, the work, and the field of the profession.

Required in Mines; elective to others; freshman year; second term; 1 credit; 1 lecture. *C. E. Newton*

MiE 143. **Explosives: Their Properties and Use.** This course offers an opportunity to students in Agriculture, Forestry, Civil Engineering, or others, to learn the principles of explosive action and to study the properties of explosives. Proper use of common high explosives; waste and danger of improper use; emphasis upon the various methods of using explosives as applied to farming, road building, etc.; actual field practice in loading and firing; blasting with the aid of electricity.

Prerequisite: General Chemistry. Elective; third term; 2 credits; 1 lecture each week; 4 three-hour laboratory periods during the term. Fee $1.00. *J. H. Batcheller*

MiE 243. **Excavation, Explosives, and Blasting.** Methods and cost of earth and rock excavation, tunneling, and shaft sinking; study of explosives used in mining and excavation work; methods of handling and storing explosives; methods of blasting.

Elective; sophomore year; third term; 3 credits; 3 lectures. *J. H. Batcheller*

MiE 343. **Mining Machinery and General Mining.** A study of mining machinery and equipment used in general mining and prospecting work; brief discussions and illustrations of general mining operations, including metal, coal, and oil.

Required in Mines; junior year; third term; 3 credits; 3 recitations. Text: Young, Elements of Mining. *J. H. Batcheller*

MiE 353. **Mine Surveying.** Study of the methods of surveying as used on surface and underground in connection with mining operations, United States land subdivision and mining laws; claim

surveys and locations; patent work; topographic surveys and maps; underground methods of traversing; stope measurement; connections; a field trip during the last two weeks of the term to some mine in the vicinity of the College.

Required in Mines; junior year; third term; 3 credits; 2 recitations; 1 laboratory period. Fee $2.00. Text: Peele, Mining Engineers Hand Book. *J. H. Batcheller*

MiE 441. **Mining Methods.** A comprehensive study and comparison of all systems of mining; a detailed study of the advantages and disadvantages of various stoping methods, methods of development, and of carrying on simultaneously developing and producing.

Required in Mines; senior year; first term; 4 credits; 4 recitations. Texts: Young, Elements of Mining. Peele, Mining Engineers Hand Book. *J. H. Batcheller*

MiE 442. **Mining Engineering.** A study of the control and coordination of all the major activities of mine operations (developing, mining, transportation of ore, milling, production of power, and marketing of products), by cost accounting and technical records, supplemented by design of general plant mine layout and special features.

Prerequisite: MiE 441. Required in Mines; senior year; second term; 4 credits; 2 recitations; 2 three-hour laboratory periods. Fee $2.00. Text: Hoover, Principles of Mining. *J. H. Batcheller*

MiE 443. **Mine Management.** A study of the economic factors affecting mining enterprises, the restrictions imposed by the mining laws of the United States, Canada, and Mexico, the methods of handling employees, the examination and appraisal of prospects and mines, methods of keeping abreast of progress in the profession through abstracts of current technical journals and mining institute publications.

Required in Mines; senior year; third term; 3 credits; 3 recitations. *J. H. Batcheller*

MiE 641. **Mine Economics and Mining Law.** Study of the costs of mining; methods of mine accounting and cost keeping; mining laws of the United States, Canada, and Mexico.

Elective; senior year; first term; 3 credits; 3 recitations. *J. H. Batcheller*

MiE 642. **Mine and Power Equipment.** Study of surface and underground equipment for mines, including haulage systems, hoists, compressors, drills, pumps, etc.; discussion of the sources of power,

water, hydroelectric, steam, gas, and compressed air; problems illustrating their application to mining methods.

Elective; senior year; second term; 3 credits; 3 recitations.
J. H. Batcheller

MiE 643. **Mine Plant Design.** The student designs and details plans and specifications for mine equipment to meet the requirements of a hypothetical mine.

Elective; senior year; third term; 2 credits; 2 three-hour laboratory periods. Fee $2.00. *J. H. Batcheller*

CHEMICAL ENGINEERING

Floyd Elba Rowland, Ph.D., Professor of Industrial Chemistry.

Chemical Engineering has become a necessary science in the economic management of many of the industries of life. The present need in this country to create new industries to supply products of manufacture formerly imported from abroad, has emphasized the demands upon chemistry and chemical engineering.

The curriculum in Chemical Engineering is arranged so that attention is given to the fundamental principles of chemistry. Thorough courses are given in General, Analytical, Organic, and Physical Chemistry. Physics, Mathematics, and Mechanical and Electrical Engineering are also emphasized. During the course specialized work in Applied Chemistry is taken.

The courses in Industrial or Applied Chemistry given in connection with Chemical Engineering are arranged as follows: (1) Engineering Chemistry (one course); (2) Industrial Inorganic Chemistry (two courses); (3) Industrial Organic Chemistry (two courses); (4) Electrochemical Industries (one course). After performing a limited number of standard experiments in Industrial Chemistry, the student is permitted to select special problems, pertaining, for the most part, to the Northwest, thus enabling him to follow a given line more fully. Problems are studied as to (1) Raw Materials; their valuation and treatment. (2) Process; chemical control and types of apparatus employed in chemical work. (3) Products of Manufacture; their purity and uses. Methods of analysis and the processes involved in large-scale manufacture are studied as described in current literature.

Local chemical industries are visited for the purpose of observing operation on a practical scale. Companies engaged in this work have been most generous in their cooperation.

There is a great need in the West for chemical engineers to help develop the vast resources. For this reason graduates are strongly advised to take advanced work and to extend their knowledge along chosen lines of research so that they may be better fitted to attack problems on their own responsibility.

Admission. Detailed statements of entrance requirements, routine of registration, etc., are given in the special bulletin on "General Information," which is furnished on application. Applicants for admission to the degree curriculum in Chemical Engineering must be at least 16 years of age and must have completed 15 units of work in a secondary school recognized as standard, these units to include

at least 3 units of English, and 1 unit each of Elementary Algebra and Plane Geometry, together with 5 additional units of English, Mathematics, Foreign Languages, Laboratory Sciences, and History (including Civics).

DEGREE CURRICULUM IN CHEMICAL ENGINEERING

B.S. Degree

Freshman Year

	Term 1st	2d	3d
Chemical Engineering Survey (ChE 101, 102, 103)	½	½	½
General Chemistry (Ch 104, 105, 106), Qualitative Analysis (Ch 131)	5	5	5
Engineering Physics (Ph 111, 112, 113)	3	3	3
Plane Trigonometry (Mth 111), Elementary Analysis (Mth 131, 132)	4	4	4
English Composition (Eng 101, 102, 103)	3	3	3
Gymnasium (PEm 111, 112, 113)	½	½	½
Military Science and Tactics	2	2	2
	17½	17½	17½

Sophomore Year

Qualitative (Ch 233), Quantitative Analysis (Ch 244, 245)	5	5	5
Crystallography (G 214)	3	....	....
Mineralogy (G 215)	....	3	....
Advanced Engineering Physics (Ph 210)	....	....	3
Differential Calculus (Mth 251), Integral Calculus (Mth 252, 253)	4	4	4
Elementary German (ML 131, 132, 133)	3	3	3
Gymnasium (PEm 211, 212, 213)	½	½	½
Military Science and Tactics	2	2	2
	17½	17½	17½

Junior Year

Engineering Chemistry (ChE 311)	5	....	....
Industrial Inorganic Chemistry (ChE 321, 322)	....	5	5
Organic Chemistry (Ch 226, 227), Organic Analysis (Ch 328)	5	5	5
Materials of Engineering (MM 311)	3	....	....
Hydraulic Laboratory (CE 348)	....	3	....
Power Laboratory (ME 331)	....	....	3
Electives	4	4	4
	17	17	17

Senior Year

	Term 1st	2d	3d
Industrial Organic Chemistry (ChE 431, 432)	5	5	....
Electrochemical Industries (ChE 441)	....	....	5
Physical Chemistry (Ch 481, 482, 483)	3	3	3
Technical Electricity (EE 251)	3	....	....
Electrical Machinery (EE 252)	....	3	....
Metallography and Pyrometry (MM 481)	....	....	3
Introduction to Economics (ES 391)	3	....	....
National Government (PS 301), or State and Local Government (PE 302)	....	3	....
Business Organization (BA 331)	....	....	3
Electives	3	3	3
	17	17	17

COURSES

ChE 101 102, 103. **Chemical Engineering Survey.** A course of lectures for freshmen in Chemical Engineering. The course is designed to broaden the students' point of view and to bring them in closer relation with the department. The lectures include a study of great chemists, and the important chemical industries.

Required in Chemical Engineering; freshman year; three terms; 1 lecture; ½ credit each term. *F. E. Rowland*

ChE 311. **Engineering Chemistry.** A course of lectures and laboratory work on the subjects of fuel, combustion, refractories, lubricants, boiler feed waters, iron, steel, alloys, cements.

Required in Chemical Engineering; junior year; first term; 5 credits; 2 lectures; 3 three-hour laboratory periods. Fee $7.50. Deposit $2.50. *F. E. Rowland*

ChE 321, 322. **Industrial Inorganic Chemistry.** The principal inorganic industries studied in lectures and in the laboratory from the standpoint of modern scientific and applied Chemistry. The laboratory instruction is arranged to develop ability on the part of the student to carry on independent work with confidence. The principles involved in the problems are carefully studied before the laboratory manipulation is attempted.

Required in Chemical Engineering; junior year; second and third terms; 5 credits each term; 2 lecture periods; 3 three-hour laboratory periods. Fee $7.50 each term. Deposit $2.50 each term.
F. E. Rowland

ChE 431, 432. **Industrial Organic Chemistry.** Lectures and laboratory work covering the chief organic branches of industrial chemistry. Emphasis is given to the fundamental principles involved in

the various processes studied. The topics studied include: mineral, vegetable, and animal oils; soap; glycerine; rubber; leather; explosives; sugar; starches; destruction distillation of coal and wood

Required in Chemical Engineering; senior year; first and second terms; 5 credits each term; 2 lectures; 3 three-hour laboratory periods. Fee $7.50 each term. Deposit $2.50 each term.

F. E. Rowland

ChE 441. **Electrochemical Industries.** Application of the electric current to the manufacture of chemical materials by electrolytic and electrothermal methods. In the lectures and laboratory work the following topics are treated: sodium hydroxide and chlorine, hypochlorites, chlorates, perchlorates, oxygen, hydrogen, carbide, graphite, carbon disulfide, phosphorus, sodium, magnesium, aluminum.

Required in Chemical Engineering; senior year; third term; 5 credits; 2 lectures; 3 three-hour laboratory periods. Fee $7.50. Deposit $2.50.

F. E. Rowland

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